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Abstract

AN ANALYSIS OF CRITICAL EXPERIMENTS USING THE HETEROGENEOUS REACTOR THEORY

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The heterogeneous reactor theory is used for the analysis of critical experiments performed on one and multizone reactor cores. The main reason for this use was to overcome the difficulties which arise in the interpretation of critical experiments when relatively a small number of fuel elements is present and classical flux mapping techniques do not give satisfactory results.

The heterogeneous reactor theory in the two-group or continuous slowing down model offers the possibility of determining two main parameters of fuel elements: η, the number of neutrons emitted per neutron absorbed in the fuel, and γ, the number of neutrons absorbed per unit neutron flux on the fuel surface. For this purpose the number of fuel elements and core height in critical conditions have to be experimentally determined. From the results of two experiments with a different number of fuel elements independent quantities η and γ can be determined. In two-zone experiments with known fuel parameters in the reference zone and unknown in the test zone, two successive substitutions allow the determination of unknown fuel parameters.

This can be extended to the three-group model which makes possible independent determination of resonance absorption parameters of the fuel. In this case it is assumed that resonance absorption takes place on a single energy line between the first and second neutron energy group. For experimental determination of the resonance parameter it is necessary to undertake three independent critical experiments with a different number of fuel elements, or, in a two-zone system, to procede with three successive substitutions.

A series of one- and two-zone experiments performed on the RB zero power reactor using 2% enriched and natural uranium in different lattice configurations were analysed by the described method. The obtained results were tested for consistency and reproducibility and compared with the results of the standard interpretation of critical experiments based on homogenization principles. The advantages of the heterogeneous method are evident especially in two-zone substitution experiments. With a sufficient number of fuel elements both methods give equivalent results.

In conclusion, advantages and disadvantages of the heterogeneous interpretation of critical experiments are discussed.